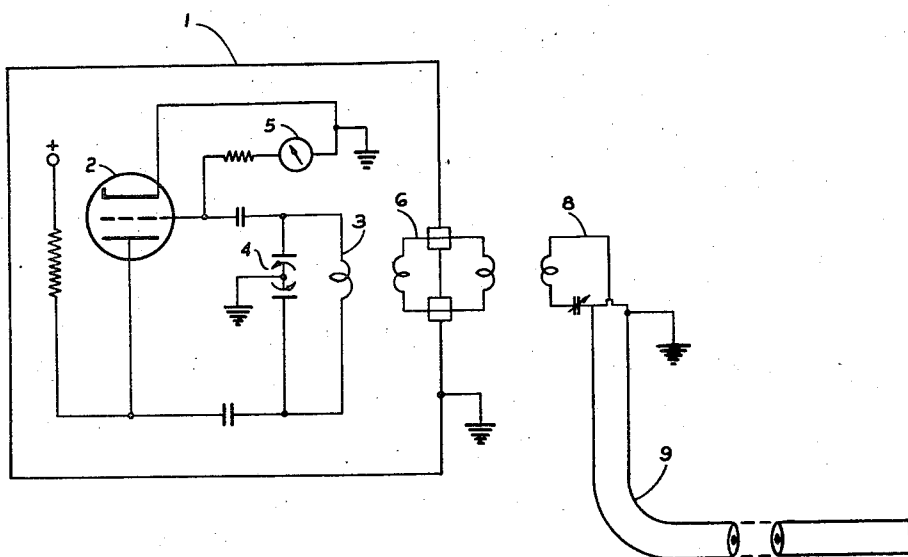


July 22, 1947.

J. M. MILLER

2,424,249

METHOD OF DETERMINING THE RESONANT FREQUENCY
OF SERIES RESONANT ELECTRICAL NETWORKS
Filed June 23, 1944



Inventor
JOHN M. MILLER

By

W. B. Jones

Attorney

UNITED STATES PATENT OFFICE

2,424,249

METHOD OF DETERMINING THE RESONANT
FREQUENCY OF SERIES RESONANT ELEC-
TRICAL NETWORKS

John M. Miller, Washington, D. C.

Application June 23, 1944, Serial No. 541,802

2 Claims. (Cl. 175-183)

(Granted under the act of March 3, 1883, as
amended April 30, 1928; 370 O. G. 757)

1

This invention relates to the problem of determining the resonant frequency of electrical networks and is particularly directed to the problem of determining the resonant frequency of transmission line sections.

It is accordingly the primary object of the invention to provide a method of ascertaining the resonant frequency of an electrical network.

It is a further object of the invention to provide a method of determining the resonant frequency of transmission line sections, from which the velocity of propagation may be derived.

The method of the present invention comprises coupling an electrical network to a variable frequency oscillator through a tunable circuit, and adjusting the frequencies of the oscillator and the tunable circuit to a value at which the latter is not detuned by the electrical network. This frequency is a resonant frequency of the network.

The invention will be further described with reference to the exemplary apparatus shown in the drawing.

The system comprises a variable frequency oscillator enclosed in a shielded cabinet 1, comprising triode 2 connected conventionally with a tuned circuit consisting of coil 3 and split stator tuning condenser 4. The tuning control for condenser 4 is preferably directly calibrated in frequency, although a wavemeter may be employed where higher accuracy is desired. Meter 5 is a D. C. milliammeter or microammeter provided for the purpose of indicating variations in the loading conditions of the oscillator. The output signal is obtained from coupling link 6 which is sufficiently closely coupled to coil 3 of the tank circuit as to permit small variations in the loading of the oscillator which will be indicated by meter 5.

The output link is coupled to a tunable coupling circuit or loop 8 comprising a coil or single turn loop in series with a small variable condenser. The electrical network whose resonant frequency is to be determined is shown as an un-terminated line section. This line section is cut to an estimated quarter wave length or odd multiple thereof. Loop 8 is connected between the two conductors at one end of the line section with the line extending at a right angle to the plane of the coil. In case a concentric line is employed, the outer conductor is grounded. In the case where a twin conductor cable, shielded and balanced to ground, is used, the loop is connected between the two inner conductors, and the shield is grounded. In the drawing, a concentric line section is shown.

2

Preliminarily, the loop terminals are both connected to the same line terminal and the coupling loop thereby shorted. Loop 8 is coupled to link 6. The oscillator is set to the estimated frequency, and the loop is adjusted to resonance as indicated by a dip in the reading of grid meter 5. The coupling of loop 8 to link 6 is then physically adjusted so as to give a small dip in the reading of meter 5 as loop 8 is tuned through resonance. The terminals of the loop are then connected across the terminals of the line section thus putting the line section in series with the loop.

Normally the estimated resonant frequency of the network or line section will differ somewhat from the actual frequency, and the coupling circuit 8 is therefore detuned. The oscillator frequency is then adjusted to resonance with the composite circuit including loop 8 and line section 9. The loop is again short circuited and returned to resonance with the adjusted oscillator frequency. The line section is again inserted in series with the loop, and the process is successively repeated until the coupling loop is not detuned by connection with the line section.

The frequency of the oscillator, as indicated by the reading of the tuning control or otherwise determined, is then the resonant frequency of the line section. Knowing in addition the length of the line section and the integral number of quarter wavelengths represented thereby, the velocity of propagation is determined.

For production use where continuous sample testing is to be performed, it is convenient to set up a standard procedure in which measurements are taken at a definite frequency such as, for illustration, 100 mc./s. For solid dielectric cables having a dielectric constant of approximately 2.25, at this frequency the wavelength within the cable will be approximately 200 cm., and three quarter wave sections 150 cm. long may be employed for testing. Under these circumstances, the velocity of propagation may be expressed in per cent of free space velocity as $\frac{3}{4} f$ where f is the resonant frequency of the described line section in megacycles. Consequently, the tuning control for oscillator 1 may be directly calibrated to give the velocity of propagation instead of frequency, although for general network measurements the conventional calibration is to be preferred.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental

3

purposes without the payment of any royalties thereon or therefor.

I claim:

1. The method of ascertaining the resonant frequency of a series resonant electrical network comprising energizing a resonant coupling circuit at its resonant frequency, connecting the electrical network in series in the resonant coupling circuit to form a combined network, adjusting the energizing frequency to the resonant frequency of the combined network, adjusting the resonant frequency of the coupling circuit to the adjusted energizing frequency, and repeating the procedure until the resonant frequency of the coupling circuit accords with that of the electrical network, at which frequency the latter does not detune the former.

2. The method of ascertaining the resonant frequency of a series resonant transmission line section comprising energizing a resonant coupling circuit at its resonant frequency, connecting

4

the transmission line section in series in the resonant coupling circuit to form a combined network, adjusting the energizing frequency to the resonant frequency of the combined network, adjusting the resonant frequency of the coupling circuit to the adjusted energizing frequency, and repeating the procedure until the resonant frequency of the coupling circuit accords with that of the transmission line section, at which frequency the latter does not detune the former.

JOHN M. MILLER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,186,184	Tubbs	June 9, 1940
2,203,878	Rosenberg	June 11, 1940